American Potato Journal

Volume XIV September, 1937 Number 9

THE MAKING OF POTATO CHIPS IN RELATION TO SOME CHEMICAL PROPERTIES OF POTATOES[1]

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Potato chips can be made from many varieties of potatoes and over a wide range of conditions. The making of good chips has been a culinary art that depended upon empirical methods and the skill of the artist. Satisfactory qualification of chips in terms intelligible to and reproducible by the reader are not well developed, but there seems to be a fairly uniform public opinion of what are good and what are bad chips. The trade demands a light-colored potato chip with a pleasant taste, tender and crisp, but not friable.

From the literature one learns that most investigations into potato chip-making have considered chiefly the initial cooking temperatures and the kinds of frying fats. Some have considered the storage conditions; a few the chemical composition of the potato. The authors of this paper believe that the constantly changing chemical composition of the stored potato accounts for the chief difficulties in the making of potato chips.

The attempts at the making of uniform potato chips raise many questions, among which three are considered in this paper: (1.) What chemical conditions of the potato affect the quality of chips? (2.) How must the frying technique be modified to suit the varying chemical condition of the potato? (3.) What is the effect of storage on the chemical composition of potatoes and the quality of chips, or on the frying technique?

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Composition

The potato is primarily a storage organ as evinced from the average chemical composition of fresh tubers given by Atwater and Bryant (3):

Average Percentage Composition of Fresh Tubers

Water	Protein	Fat	Carbohydrates	Ash
78.3	2.2	0.1	18.4	1.0

Potato composition varies with soil and fertilization but these factors may have little effect on the frying of potatoes as suggested at the Rothamsted Experimental Station by Crowther (6):

"The ammonium sulfate slightly decreased and the potassic fertilizer slightly increased the quality for steaming, but neither affected the frying quality. The amount of dry matter in the fresh tubers was affected but little by potas ium sulfate, but was somewhat reduced by potassium fertilizers containing chlorine and still more by 30 per cent potash salts."

Sweetman (14) claimed that the sugar content of potatoes has a controlling influence on the color and flavor of chips made from them.

Storage

The most obvious, and according to our present knowledge the most important physico-chemical changes during storage, involve the starches and sugars. Butler (4) states that in potatoes which have been stored below 50° F. (10° C.) the sugar increases rapidly as the storage temperature approaches 32° F. (0° C.). Appleman (1) points out from his studies with potatoes kept at 50° F. that the sugar and starch content remained practically constant for a period of two months, but potatoes held for three months at temperatures from 29° F (1.70° C.) to 42° F. (5.60° C.) contained four times as much sugar at 32° F. as at 42° F. The starch content also decreased from 14 to 12.5 per cent as the temperature decreased.

Respiration rates and carbohydrate changes have been investigated by Hopkins (8,9) who found the minimum rate to be at 37.4° F. (3° C.). Over a storage temperature range of 30.5° F. (-0.83° C.) to 52.7° F. (11.5° C.) there was the least accumulation of sugar in the tubers at 37.4° F.

In a study of the chemical composition of both mature and immature tubers in storage Appleman and Miller (2) report the following findings:

(1.) The percentage of sucrose in immature potatoes decreased during storage so that by the end of the rest period it was practically the same in all lots regardless of degree of immaturity at the time of storage. (2.) "The percentage of reducing sugars which are all very low show little change during storage when calculated on the basis of moisture content at the time of digging." (3) "The ripening and maturing processes in potatoes may continue during storage so that by the end of the rest period immature potatoes have practically the same percentage composition and respiratory response as potatoes allowed to mature on vines if both are stored under the same conditions."

Both Appleman (1) and Butler (4) state that potatoes which have accumulated sugar during storage at a too low temperature may be improved by being placed in warmer storage. Butler recommends a week or two at 68° F. (20° C.), the exact time being dependent upon the amount of sugar in the tuber at the time of removal from low temperature storage. Appleman (1) shows that such potatoes will lose four fifths of their sugar after being stored at 70° F. (21.11° C.) to 75° F. (23.89° C.) for one week. Maintaining at 45° F. (7.22° C.) to 50° F. (10° C.) for three to four weeks would produce the same results.

Chip Making Studies

Vosbury (16) was one of the earliest experimenters to establish a method for making potato chips. She recommended an immersion temperature of 410° F. (210° C.) for all fryings but observed that unless she had the relation between the quantity of potato slices and the amount of sugar in the tuber at the time of removal from low 5 minutes the chips were not satisfactory. She believed that failure to make good chips was due to use of varieties not adapted to chip making, improper washing of the slices or having the frying temperature of the oil too low.

In her experiments, Sweetman (14, 15) found that chips made from potatoes high in sugar were affected in two ways: (1.) They had a sweet, off flavor. (2.) They developed a dark brown, uneven color during the frying. The color was objectionable when the sugar content of the potato rose above one half of one per cent; also

the color of the chips seemed to be definitely correlated with their sugar content. Chips made from potatoes dug in June were browner than those of the same variety dug in August, the total sugar content for June-dug potatoes being 0.991 per cent; and for August-dug, 0.251 per cent. From this standpoint it would seem that mature potatoes should be more desirable for chip-making than immature when chips are made from potatoes before they have been in storage long enough to reach constant respiration.

At the U. S. Bureau of Home Economics, Peacock, et al. (11) stored potatoes grown under known conditions. The storage temperatures, 36° F. (2.22° C.), 40° F. (4.44° C.), 50° F. (10° C.), 60° F. (15.56° C.) and 70° F. (21.11° C.) were maintained for nine weeks with humidity controlled. Only the potatoes held at 60° and 70° F. made excellent chips. A storage at 50° F. produced chips of fair quality whereas the potatoes held at 36° and 40° F. were not edible when made into chips by the method used. When potatoes were held for a week at 60° F., after storage at 36° 40° and 50° F., the chips were not materially improved. The authors immersed the potato slices in oil at 410 F. (210° C.) and cooked them either for a definite time or for the best possible color. They do not state, however, the amount of fat used nor the amount of potatoes fried at a time, and the actual frying temperature is not given. Might a lower immersion temperature have made a good product with potatoes stored at 50° F.?

Woodruff and Blunt (18) describe the frying of potato slices in both animal and vegetable fats at various temperatures. They fried not more than five slices at once. The temperature change was never more than 3° above or below the immersion temperature.

"The chips fried in lard at 170° and 190° were the best looking; those fried in lard at 210° and in Wesson oil at 190° and 210° were a little overbrowned on the edges before the center had thoroughly cooked."

The potatoes were cooked as nearly as possible to the same brown color although the authors report that some were more evenly browned than others, which they attribute, in part, to the differences in the potatoes.

Chitwood and Vail (5) report a study on making potato chips, from the Irish Cobbler potato in which they used several different fats, both animal and vegetable, and cooked the potato slices in each fat at the temperatures of 330° F. (165° C.), 350° F. (175° C.), and 370° F. (188° C.). Judging their chips upon crispness, flavor and ap-

pearance, the potato slices cooked at 370° F. (188° C.) for four minutes gave the best products. Whether 370° F. was the final frying temperature or only the immersion temperature, the authors do not state.

Whittemore and Kuschke (17) made chips from potatoes fertilized with varying amounts of potassium. To test the assumption that potatoes high in nitrogen produce crispness in chips, the potatoes were made into chips, when by analyses they "showed the greatest and least range of nitrogen content from different plots." The chips judged highest were made from potatoes fertilized with a small amount of potash, regardless of the nitrogen content. According to judgments for boiling, baking and mashing, these same potatoes were the least mealy.

Experimental Methods

As previous unpublished experimental work (13) at Minnesota agreed with the findings of others, that potato chips changed in character with the length of time potatoes were in storage, it seemed wise to approach this problem from the standpoint of chemical composition of the potatoes as well as from their cooking difficulties.

The following varieties of certified Minnesota potatoes exhibiting varying qualities for chip-making were chosen: the Warba, the Russet Burbank, and the Chippewa.[1]

The frying vessel was a deep-fat fryer 20 cm. bottom diameter, 25 cm. top diameter and 12.5 cm. deep, 1200 grams weight complete with wire basket in which the chips were placed for frying to facilitate removal from the frying fat when cooked.

Methods

The potatoes were made into chips after being out of storage and at room temperature for varying lengths of time. To study what effect the chemical composition of the tubers might have upon their chip-making qualities, samples were taken on the day of chip preparation for ash, dry matter, and crude protein, and tests were made for reducing sugars, by the picric acid-sodium carbonate test, as described

[1]The potatoes used were grown at the Grand Rapids Experiment Station, harvested on the 28th of September, 1934, and were held in storage at 40° F. (4.4°C.). They reached the University Farm in excellent condition early in February, 1935, and were immediately placed in the potato storage cellar, which had a temperature range varying from 35° to 42° F. (1.7°-5.6° C.), from February to May, 1935.

by Peacock and Brunstetter (10), to serve as a semi-quantitative measurement for the amount of sugar in the potatoes.

One variety of potato was handled at a time. The potatoes were not pared but carefully scrubbed and all blemishes removed. All potatoes used on a day were cut at one time in a mechanical slicer which delivered sections 1.5 mm. (1/16 in.) thick. The flat receiving tray was rapidly moved about to distribute slices from each potato in order to effect better sampling for the chemical analyses and the frying.

Samples for Chip Making

Eight 120-gram lots of whole slices were soaked for 30 minutes in cold running water, drained and blotted between paper towels until surface moisture was removed, weighed again and fried in the frying basket in a hydrogenated vegetable oil. Starting with 1815 grams (4 pounds) of oil and cooking the 120-gram original portions of soaked, blotted slices, the potatoes were subjected to the fat at initial temperatures ranging from 325° to 375°F. (163°-190.6° C.) and cooked from 105 to 180 seconds. When the chips were sufficiently browned the oil was drained into the kettle from the basket, the chips were weighed on paraffined paper, judged and stored in air-tight containers for future study. After each frying the kettle was weighed to measure the fat required for a test cooking. The differences between the kettle weights after each frying are a measure of the fat required in the frying of the samples of slices. This difference does not mean that all of the fat lost from the kettle was absorbed by the slices, but it does indicate the relative fat consumption of various kinds of potatoes in the making of chips. (See "fat required" column in table I.)

Dry Matter and Ash

Eighteen samples of freshly-cut potatoes, each sample weighing about 10 grams, were taken. Nine of these samples as slices were soaked for thirty minutes in cold running water, again weighed, and cut up for drying. They were dried to constant weight at 105° to 110° C. The per cent dry matter was expressed on the original weight. The samples were ignited by the Hertwig-Bailey (7) method as adapted by Rogers (12) to plant tissues and the ash expressed as per cent of dry weight.

Nitrogen

Eight to ten fresh samples of from fifteen to twenty grams each, half of them soaked for thirty minutes in cold running water, drained and blotted on paper towels, were used for estimations of nitrogen by the Kjeldahl method.

Experimental Results

Frying

The data in table 1 show that of the three varieties used, the potato slices of any one variey that required the greatest amount of fat in cooking did not necessarily produce the heaviest chips. There are perhaps several reasons for this, two of which appear in this study:

(1) *Water absorbed by the slices.*

In table 1, it is observed that each variety of potato varied considerably in the amount of water absorbed by the same weight of cut potato slices. Throughout the experiment the Burbank absorbed the least, Chippewa the most, and the Warba an intermediate amount, but with the greatest range of variation. Nevertheless, the wide range in weights of samples of slices of all varieties after soaking (ranges not shown in table 1) renders insignificant small differences in their averages.

On the average the Warba slices absorbed a little more water than the Burbank, which absorbed the least. The Chippewa absorbed the most water and produced the lightest chips.

Within a variety and among varieties there seemed to be no apparent relation between the water absorbed by cut slices and the fat required, or water absorbed and weight of chips produced from 120 grams of potato slices.

The Burbank and Warba produced chips of approximately the same weight from 120 grams of potato slices.

(2) *Fat required in the frying.*

In table 1 are compared the weights of the fat required by the

TABLE 1.—*Time of storage, cooking conditions and average* weights of soaked slices, chips and fat required by three varieties of potatoes*

Date 1935	Time from Harvest at 35° to 45° F.	Time at 75° F.	Limits of Cooking Time	Limits of Temperature of the Fat at End of Frying	Weight of Slices (120 grams) (Soaked 30 min. running water)	Weight of Chips from Soaked Slices (120 grams before soaking)	Percentage Chips Are of Original Weight	Fat Required (Based on Loss in Kettle Weight)	Percentage of Fat in Chips (Fat required /120g.)
	Days		Seconds	°F.	Grams	Grams		Grams	
CHIPPEWA VARIETY									
2-12-	133	3	120-135	285-300	126.2	36.4	30.4	16.3	13.5
2-21-	137	8	105-180	275-300	127.0	38.9	32.4	16.5	13.6
4-17-	195	5	120-140	250-290	126.4	41.9	34.9	19.1	16.0
Varietal averages					126.5	39.2	32.6	17.3	14.4
RUSSET BURBANK VARIETY									
2-28-	142	10	105-120	285-310	124.3	44.4	37.0	16.5	13.7
3-14-	156	10	105-120	310-320	124.9	45.8	38.2	16.5	13.7
4-24-	202	5	105-180	270-290	123.5	45.5	37.9	17.6	14.5
Varietal averages					124.3	45.3	37.7	16.9	14.0
WARBA VARIETY									
3-5-	142	15	105-120	275-300	118.1	42.7	35.6	15.7	13.1
4-10-	193	0	90-150	275-294	130.1	48.0	40.0	20.4	17.0
5-1-	209	5	120-180	250-285	127.8	44.3	36.9	16.4	13.7
Varietal averages					125.3	45.0	37.5	17.5	14.6

*Averages in dated rows for each variety are based on eight replications of each weight or percentage given.

slices and the percentages those fat weights are of the original slices. The Burbank which showed the least sprouting and by the picric acid test (table 2) the least accumulation of reducing sugars, was the most constant in fat requirement regardless of the initial temperature of the fat. This variety of potato used the least fat of all three varieties. The most noticeable variation in fat requirement in each potato variety was at the time of the last preparation of chips when the potatoes had accumulated their highest amount of sugar.

The Chippewa in the last cooking showed the greatest range and greatest variations in fat requirement; here again the sugar content was highest. Chippewa used the intermediate amount of fat.

The Warba, which was high to moderate in sugar content through-

TABLE 2.—*Relation of variety, frying temperature, frying time and sugar content of potatoes to the qualities of chips.*

Date 1935	Samples Nos.	Temperatures Initial °F	Initial °C	Frying °F	Frying °C	Drop °C	Frying Time Seconds	Sugar by Picric Acid Tests	Color; flavor; other qualities
				CHIPPEWA VARIETY					
2-12-	10-16	375	190.5	295	146.0	44.5	120-135	Medium	uneven; poor flavor, slightly burned
2-21-	24	375	190.5	300	149.0	41.5	120	"	uneven; poor flavor; slightly burned
2-21-	25	365	185.0	300	149.0	36.0	135	"	decidedly burned flavor
2-21-	26, 27	365	185.0	295	146.0	39.0	120	"	uneven; strong, but not burned
4-17-	70, 72, 74, 77	350	176.5	285	140.5	36.0	135-140	" plus	slightly uneven; more pleasing than samples 26 and 27
4-17-	76	350	176.5	275	135.0	41.5	135	" "	*slightly uneven, not too dark; mild very tender
				RUSSET BURBANK VARIETY					
2-28-	30	365	185.0	310	154.0	31.0	105	Small	slightly uneven, general effect light; mild
2-28-	32	365	185.0	290	143.0	42.0	120	"	even, golden; mild; crisp, tender
2-28-	35	365	185.0	285	140.5	44.5	120	"	even; crisp, tender
3-14-	51, 52	375	190.5	310	154.0	36.5	105	"	uneven; slightly burned taste
4-24-	80, 84	350	176.5	285	140.5	36.0	120	" plus	even, golden; tender, crisp
4-24-	81-83	350	176.5	280	138.0	38.5	135	" "	even, light
4-24-	85-87	340	171.0	270	132.0	39.0	120-135	" "	*even, golden; excellent flavor; tender
				WARBA VARIETY					
3-5-	45	350	176.5	300	149.0	27.5	120	Large	even, slightly dark; taste somewhat burned
4-10-	61	355	179.0	275	135.0	44.0	140	Medium	even, good color; leathery, underdone
4-10-	62	355	179.0	285	140.5	38.5	135	"	even; no burned flavor
4-10-	63	355	179.0	290	143.0	36.0	135	"	uneven, dark; caramelized, tough
5-1-	90	350	176.5	295	146.0	30.5	120	"	uneven, too dark; leathery
5-1-	91	340	171.0	285	140.5	30.5	120	"	uneven, few too dark in spots; no burned flavor
5-1-	93-95	325	163.0	270	132.0	31.0	165	"	*even, light golden; mild, crisp, tender

*The best chips from each variety. The Burbank produced fairly good chips under most frying conditions.

out the experiment, always showed a wide variation in the amount of fat required, and used the most fat while cooking.

From table 1 it will be noted that with all three varieties there was a tendency for the amount of fat required to increase slightly with a lowering of the final cooking temperature. A decrease in the cooking temperature also meant a slight increase in cooking time. (See table 2).

The weight of chips produced from 120 grams of soaked and blotted slices appears, from a study of these cooking records, to be dependent upon the following factors: (1) The change brought about in the chemical composition of the potato during soaking due to, (1) (a) loss of contents of cut cells; and (b) the amount of water absorbed, which determined the difference between the weights of the soaked and unsoaked slices; (2) loss of water in frying and (3) the amount of fat acquired by the slices during frying.

The last two were factors of some importance in the weights of chips produced from the three varieties.

The chemical and physical properties of the substances within the slices and their interaction with the cooking medium, must provide the ultimate factors that determine the quality of the chips.

Transformation of Slices into Chips

Vosbury (16) described the change of potato slices into chips. She pointed out that the water must be boiled off before the potato slices could become chips, and that a minimum temperature of the fat for the production of good chips must be maintained. Her observations have been qualitatively corroborated by later work.

During the production of the chips characterized in table 2, the conditions that accompanied the transformation of slices into chips were noted in some detail.

When a weighed amount of soaked slices was put into the hot fat, at a recorded initial temperature, the ensuing violent ebullition of water vapor was accompanied by a rapid fall in the temperature of the fat, which fall continued until most of the water was driven off. The temperature ceased to fall when the ebullition moderated, and remained almost constant during the rest of the frying. When the excessive bubbling diminished, the slices were still limp and white. The slices assumed color and crispness to become chips between the time the bubbling moderated, and the end of the frying.

It may therefore be considered that the part of the frying process

that determines the quality of the chip, takes place after much of the water is driven off, and the slices have approached the temperature of the frying fat. It is impossible to raise the temperature of the slices above the boiling point of the water present while it is stiil evaporating.

When evaporable water is gone, the heat that the slices absorb, raises their temperature. Thereafter color and crispness appear. As the temperature of the fat remains practically unchanged after ebullition moderates, this temperature may be called the frying temperature.

Frying Temperatures of Fat in Relation to Quality of Chips

It was developed in the historical part of this study that one of the greatest difficulties in the making of potato chips is the choice of a proper frying temperature (5, 13, 16). When potatoes are in the early resting stage, the choice of a frying temperature is not particularly difficult. As storage progresses, however, the difficulties increase. When potatoes are held in storage, their physical and chemical properties change at rates different for each variety or condition of storage. The most easily notable of these changes, and perhaps the most important to the maker of potato chips, is the increase in sugar content with time of storage, and with the tendency to sprout. After long periods of storage, some potatoes seem to be more withered than others, but even these are made into merchantable chips in some places.

In her previous work Rogers (13) found that no one frying temperature could be used for making chips from any one variety throughout its storage period; neither would one frying temperature of the fat that made good chips with one variety of potato work equally well with another variety produced and stored under conditions as nearly identical as possible.

As the frying experiment progressed, it was noted that the difficulties of producing a good quality of chips were much greater with the Warba or Chippewa than with the Burbank. The slices from the Warba or Chippewa would often cook unevenly and become too dark in places, resulting in sweet or burnt-flavored chips. A shortened frying time resulted in underdone leathery chips.

The sugar content of both the Chippewa and Warba varieties tested high during some phase of their storage, whereas that of the Burbank was never more than moderate. (See table 2). Satisfac-

tory chips could be made from the potatoes high in sugar if they were subjected to a lower frying temperature than those used with potatoes containing less sugar.

In general, the slices from potatoes giving a red color with picric acid made desirable chips when immersed in fat at a temperature as low as 325° F. (163° C.), and fried at 270° F. (132° C.). The Burbank potatoes, which, with picric acid never tested above a deep orange color, ("small plus" in table 2), upon immersion at a temperature of 365° F. (185° C.), produced good chips at the first cooking, but as the sugar increased, fat temperatures of 340° F. (171° C.) for immersion, and 270° F. (132° C.) for frying produced better chips. Similar trends were even more obvious in the Chippewa and the Warba. With all varieties, as the immersion temperature was lowered, the frying temperature was correspondingly lowered, and the cooking time somewhat increased

With the picric acid tests to indicate the sugar content of the potato, the proper frying temperature could be predicted within 18° F. (10°C). The frying time had to be adjusted to the rate at which the chips browned, or to the degree of color desired. A frying temperature as low as 250° F. would not fry potato slices crisp, but at 270°-275° F. (132°-135° C.) potatoes high in sugar could be made into satisfactory chips. Table 2 shows that the Burbank, which always contained the least amount of sugar at any storage period, produced good chips over a fairly wide frying temperature range, whereas the Chippewa and Warba produced good chips over a much narrower frying temperature range.

It may be seen from this table that the qualities of the chips are related more obviously to the final frying temperature of the frying process than to any single measured factor given in the table.

Woodruff and Blunt (18) who fried a few slices at a time with only a small temperature drop in the fat, were probably holding their system at the frying temperature all of the time. They used a high fat temperature and a short period of time. By their technique, they escaped any marked temperature change, but the short frying time probably did not allow the slices or chips to fully attain the fat temperature they maintained.

The data of Rogers (13) agree with those in table 2 to indicate that the final or *frying temperature* is the important factor for making chips from any kind or condition of potatoes. The necessary time of exposure of slices to frying temperature depends upon their composition, but unless the temperature is within a proper range, *good*

chips cannot be made no matter what the time of exposure. Time of frying is, therefore, secondary to frying temperature.

What determines the initial fat temperature?

Accepting the frying temperature as a fundamental factor in chip-making for any given condition and composition of potato slices, the temperature of the fat at the time of immersion of slices is important only as an indication of the presence of a sufficient amount of heat in the cooking system to evaporate the water within the slices without delay and to leave the fat at a temperature within the proper frying range.

The heat consumed must come from the fat and the containing vessel. During the frying of the slices there is some absorption of heat by the vessel from the source of heat. As was indicated above, the temperature ceases to fall when excessive ebullition is over. The initial temperature of the frying fat will therefore depend on the heat capacity of the system, the heat requirements of the slices to be fried at one time, and the amount of heat absorbed from the source of heat during frying.

The heat capacity of the system is the product of the mass of the system by the specific heat, and the heat *content* is the product of the heat capacity by the temperature. The heat loss or gain of the system is the product of the heat capacity by the temperature change.

Fat/Slice Ratio

Presumably the energy requirements in terms of heat units for boiling off the water and frying a definite mass of potato slices is reasonably constant. With a large mass of frying fat compared to the mass of slices the temperature drop of the fat would be small.

Woodruff and Blunt (18) who used about 750 grams of fat for frying 3 or 5 slices at a time, noted only a small temperature change. Into 1000 g. of fat at 400° F. (204.4° C.) Sweetman (14) dropped ten potato slices at once. She noted a 50° F. temperature drop for a short time at first, but the temperatures of the fat in her experiment rose rapidly due to high heat intake during frying. The frying temperature of her experiments was inconstant over a range of 350° F. to 375° F. (176.7° to 190.6° C.). But the experiments now under discussion indicate, as do those just cited, that the relation of the mass of fat to the mass of slices introduced at one time is important in that this ratio, which may be called the "fat/slice ratio", will at least in part determine the initial temperature of the frying fat.

The most important consideration in the making of potato chips is the frying temperature as herein defined. The "fat/slice ratio," the initial temperature and the rate of heat intake of the frying system, all contribute to the attainment and maintenance of the proper frying temperature, but our experimental data do not permit the exact numerical statement of the relationship of the one to the other.

Picric Acid Tests for Sugar and Qualities of Chips

When the potatoes, in storage at temperatures ranging from 35° F. (1.67° C.) to 42° F. (5.56° C.), were tested for reducing sugars, it was found that the sugar in each variety was higher than when the potatoes were received. The amount of sugar accumulated seemed to be associated partly with variety and partly with the keeping qualities of the potatoes. Throughout the storage period, the Russet Burbank showed little sign of sprouting and remained firm. The Warba sprouted the most, which may be caused, in part, by the fact that this variety was kept in storage a week longer than the Burbank, and two weeks longer than the Chippewa. Although the sprouts on the Warba, on the last date of preparation, varied from ¼ to 1 inch in length, the potatoes remained firm. The Chippewa showed sprouts from almost nothing to approximately a quarter of an inch in length on the last date of preparation, at which time these potatoes were rather soft and somewhat withered.

From table 2 it will be noted that the Burbank showed the least amount of sugar accumulation and that the increase throughout the storage period was slight. The color varied only from deep yellow to orange. These results seemed consistent with the dormancy of the potatoes as they were practically sproutless after seven months of storage. The Chippewa on the 12th of February, after 136 days of storage, gave a picric acid test that indicated a medium amount of sugar. This slowly increased from the first to the last test, the color change deepening from a light to a medium red. The varying lengths of time the potatoes were out of storage and exposed to room temperature apparently had no effect upon the accumulated sugar. The Warba showed inconsistent results with the picric acid tests, for in spite of the fact that the potatoes were well-sprouted May 1st, 214 days after harvest, with 209 days at continuous low-temperature storage, this test showed that the potatoes contained less sugar than on the other two dates of frying. The sugar decreased from a high to a moderate amount.

During the storage period in which the picric acid tests were taken, the amounts of reducing sugars present within each variety varied over a narrow range, whereas the range among varieties was wide. The Burbank contained much less than either of the other varieties. Room-temperature storage did not perceptibly lower the sugar in the three varieties used in this problem. Some 1935 Bliss Triumph potatoes held continuously at room temperature for one month showed a slight lowering of the sugar content as the tests changed color from light red to orange.

The greatest effect of storage is upon sugar content, and as is shown later, sugar content largely determines the final frying temperature of the fat.

Chemical Composition

The potatoes were analyzed for dry matter, ash and crude protein. In table 3 it will be noted that the per cent dry matter was highest in the Burbank, intermediate in the Warba and lowest in the Chippewa. Upon soaking, the potato slices were found to lose dry matter in varying quantities as indicated by the range of dry matter shown in this table. The loss was similar and highest in the Chippewa and the Burbank, and lowest in the Warba when the percentage was figured upon the unsoaked original weight of the slices. Upon the soaked weight, the percentage loss was most with the Burbank, intermediate with the Chippewa and least with the Warba.

As the weight of the chips produced from 120 grams of potato slices was in the same order as the percentage of dry matter found to be present in the three varieties of potatoes there appears to be some relation between per cent dry matter and the weight of chips produced.

Table 4 shows that the Chippewa contains the highest per cent of ash, the Warba the least, and the Burbank an intermediate percentage. This same order was maintained upon soaking the slices, although the Burbank lost the most ash and the Chippewa an intermediate amount.

With such slight variation in the percentages of ash among the three varieties there appears to be no demonstrable relationship between ash and quality of chips, or between ash content and weight of chips.

From table 5 it is noted that the Burbank contained the highest percentage of nitrogen whereas the Warba and Chippewa contained practically the same amounts; each lost practically the same amounts; each lost practically the same percentage with soaking although the Burbank lost the most,—the loss being about 6.5 per cent more than Warba and Chippewa.

TABLE 3.—*Dry matter of soaked and unsoaked potato slices.*

Variety	Date 1935	No. of Samples	Treatment	Average Per Cent Dry Matter		Ranges of Percentages*		Average Variations of Percentages	
				on "as cut" Basis	on "soaked" Basis	on "as cut" Basis	on "soaked" Basis	on "as cut" Basis	on "soaked" Basis
Chippewa	2-12-	9	Unsoaked	18.67		1.32		±0.24	
	2-12-	7	Soaked	16.45	15.43	3.39	1.49	±1.09	±0.45
	2-21-	7	Unsoaked	21.56		3.00		±0.66	
	2-21-	9	Soaked	18.06	17.88	2.50	4.80	±0.51	±0.94
	4-17-	9	Unsoaked	20.85		1.47		±0.43	
	4-17-	9	Soaked	19.94	17.95	2.01	2.16	±0.67	±0.67
Column averages			Unsoaked	20.36		1.93		±0.44	
			Soaked	18.15	17.23	2.63	2.82	±0.76	±0.69
Russet Burbank	2-28-	9	Unsoaked	27.16		1.29		±0.38	
	2-28-	9	Samples insufficient for soaking test.						
	3-14-	9	Unsoaked	27.05		0.99		±0.30	
	3-14-	9	Soaked	24.64	22.82	3.11	1.53	±0.73	±0.39
	4-24-	9	Unsoaked	26.12		0.78		±0.22	
	4-24-	9	Soaked	23.88	21.53	3.05	2.48	±0.78	±0.73
Column averages			Unsoaked	26.78		1.02		±0.30	
			Soaked	24.26	22.18	3.08	2.00	±0.76	±0.56
Warba	3-5-	9	Unsoaked	24.70		1.30		±0.29	
	3-5-	9	Soaked	20.91	20.02	4.40	4.30	±0.08	±1.21
	4-10-	9	Unsoaked	22.12		3.52		±0.61	
	4-10-	9	Soaked	22.46	19.91	2.58	2.86	±0.64	±0.63
	5-1-	9	Unsoaked	23.76		2.04		±0.40	
	5-1-	9	Soaked	21.78	19.73	3.04	2.21	±0.63	±0.43
Column averages			Unsoaked	23.53		2.29		±0.43	
			Soaked	21.72	19.89	3.67	3.12	±0.78	±0.76

* "Range" is the difference between the highest and lowest replicates.

On the basis of picric acid tests, part of which are recorded in table 2, the sugar content of all the potatoes tends to increase even when measured after they have been held in storage at 75° F. for some days after being removed from the lower temperature, before they were tested. As all of these potatoes had been grown under conditions as nearly identical as possible, the observed differences in behavior of the potatoes with respect to sugar content may be attributed to varietal differences. In table 2 are compared the picric acid tests for sugar with the frying time, temperatures, and the qualities of the resulting chips.

TABLE 4.—*Per cent ash of the dry matter of the soaked and unsoaked potato slices.*

Variety	Date 1935	Number Samples	Treatment	Average Per Cent Ash on "as cut" Basis	Ranges of Percentages* on "as cut" Basis	Average Variations of Percentages on "as cut" Basis
Chippewa	2-12-	8	Unsoaked	4.09	0.86	±0.26
	2-12-	5	Soaked	4.16	0.78	±0.23
	2-21-	9	Unsoaked	3.65	1.68	±0.30
	2-21-	9	Soaked	3.40	0.41	±0.14
	4-17-	9	Unsoaked	3.84	0.70	±0.19
	4-17-	9	Soaked	3.36	0.37	±0.45
Variety averages			Unsoaked	3.86	1.08	±0.25
			Soaked	3.64	0.85	±0.27
Russet Burbank	2-28-	9	Unsoaked	3.30	1.05	±0.20
	2-28-	0	No samples			
	3-14-	7	Unsoaked	3.22	0.23	±0.09
	3-14-	9	Soaked	3.06	1.28	±0.30
	4-24-	9	Unsoaked	3.23	0.70	±0.21
	4-24-	9	Soaked	2.66	0.48	±0.15
Variety averages			Unsoaked	3.25	0.66	±0.17
			Soaked	2.86	0.88	±0.23
Warba	3-5-	9	Unsoaked	2.93	1.98	±0.38
	3-5-	9	Soaked	2.97	1.27	±0.34
	4-10-	9	Unsoaked	3.28	0.31	±0.10
	4-10-	9	Soaked	3.02	0.47	±0.10
	5-1-	9	Unsoaked	2.74	0.19	±0.06
	5-1-	9	Soaked	2.48	0.68	±0.15
Variety averages			Unsoaked	2.98	0.83	±0.18
			Soaked	2.82	0.81	±0.20

* "Range" is the difference between the highest and the lowest percentage.

TABLE 5.—*Per cent nitrogen by Kjeldahl on original weight of potato slices.*

Variety	Date 1935	No. of Samples	Treatment	Average Per Cent of Nitrogen on "as cut" Basis	Ranges of Percentages* on "as cut" Basis	Average Variations of Percentages on "as cut" Basis
Chippewa	2-12-	3	Unsoaked	0.350	0.026	±0.010
	2-12-	4	Soaked	0.277	0.027	±0.012
	2-21-	4	Unsoaked	0.333	0.009	±0.003
	2-21-	3	Soaked	0.292	0.056	±0.022
	4-17-	4	Unsoaked	0.402	0.036	±0.012
	4-17-	4	Soaked	0.336	0.050	±0.021
Variety averages				0.362	0.024	±0.008
				0.302	0.044	±0.018
Russet Burbank	2-28-	4	Unsoaked	0.490	0.028	±0.010
	2-28-	4	Soaked	0.346	0.065	±0.023
	3-14-	3	Unsoaked	0.462	0.001	±0.001
	3-14-	4	Soaked	0.371	0.096	±0.039
	4-24-	3	Unsoaked	0.469	0.015	±0.006
	4-24-	4	Soaked	0.371	0.018	±0.006
Variety averages			Unsoaked	0.474	0.015	±0.006
			Soaked	0.363	0.060	±0.023
Warba	3-5-	4	Unsoaked	0.405	0.061	±0.017
	3-5-	3	Soaked	0.309	0.018	±0.006
	4-10-	4	Unsoaked	0.354	0.012	±0.005
	4-10-	4	Soaked	0.325	0.107	±0.028
	5-1-	3	Unsoaked	0.369	0.118	±0.050
	5-1-	3	Soaked	0.281	0.020	±0.007
Variety averages			Unsoaked	0.376	0.064	±0.024
			Soaked	0.305	0.048	±0.013

* "Range" is the difference between the highest and the lowest percentage.

The increase of sugars in these potatoes is greatest in the Warba, and least in Russet Burbank. The sugar content seems to be the most obvious chemical condition of potatoes that is related to the quality of chips produced or to the proper frying temperature. Table 2 shows, that as the sugar increases, the frying temperature for good chips must be decreased and the limits of the frying temperature over

which good chips can be made becomes much narrower. A small, but fairly uniform increase in cooking time with the lower temperature, is indicated in table 2. The last column of this table supports the idea that potato chips with fair to good quality may be produced from potatoes late in storage by proper modification of the frying temperature and frying time.

Storage of Potatoes

Only the later part of the storage period of the potatoes studied was involved, so that it is impossible to conclude what the whole effect of storage might be upon the quality of chips or the range of conditions over which acceptable chips could be produced.

Table 6.—*Relation of variety, storage period, chip weight to dry matter, ash and nitrogen of soaked potato slices*

Variety	Date	Samples No.	Average Chip Weight Grams	Average Fat Used	Dry Matter	Ash Per-centages	Kjeldahl Nitrogen
Chippewa	2-12-	10-16	36.4	16.3	15.83	4.16	0.277
"	2-21-	20-27	38.9	16.5	17.88	3.40	0.292
"	4-17-	70-77	41.9	19.06	17.95	3.36	0.336
Russet Burbank	2-28-	30-37	44.4	16.5	....	...	0.346
"	3-14-	50-57	45.8	16.5	22.82	3.06	0.371
"	4-24-	80-87	45.5	17.6	21.53	2.66	0.371
Warba	3-5-	40-47	42.7	15.7	20.02	2.97	0.309
"	4-10-	60-67	48.0	20.4	19.91	3.02	0.325
"	5-1-	90-97	44.3	16.4	19.73	2.48	0.281

Table 6 compares the average weight of chips of each date of frying with fat absorption, and the dry matter, ash and Kjeldahl nitrogen of *soaked slices*. The soaked slices were used for this comparison because they would be a more nearly accurate measure of the potatoes used for frying. It may be noted that, as the storage progressed, chip weights tended to increase along with the fat used, and with the increase of percentage of dry matter and nitrogen in the soaked slices. As usual in this study the Warba variety furnishes the exceptions and greatest variations, but the Russet Burbank shows the greatest consistency in all measurements, and the least change during the storage period. It appears from this

table that the processes in storage produce a condition within the potato permits an increase in diffusibility of ash constituents when soaked, but crude protein in soaked slices, although lower than in the unsoaked slices tends to be lost less rapidly in the potatoes stored for the longest period. In two of the varieties such an observation could be made, but the Warba variety supplied the usual exception.

There is no significant change in the dry matter content of the potatoes during storage in any variety, but the dry matter content of each variety is significantly different.

Conclusions

There seems to be little question that the chemical composition of the potato slices, especially their sugar content, determines the quality of chip that can be made by a fixed frying technique. It seems, however, to be more important to discover what is the proper frying technique for the production of good chips than to describe the chemical changes of the potato in storage. The gross chemical composition is probably only a portion of the explanation why chips come from the frying fat in the condition they do, and it is also only a portion of the physico-chemical complex that determines the conditions of frying that will produce acceptable chips.

Consideration of the data presented and the chips produced have led to the conclusion that good chips can be made from the right kind of potatoes after long periods of storage, and that the effect of storage should be sought less in the quality of the chip produced from a rigidly standarized process of frying, than in the modification of the frying process to obtain chips of fairly uniform quality. Such modifications of process were shown to consist mostly in the adjustment of the frying temperature and the frying time.

The transformation of slices into chips involves the evaporation of water and the crisping and browning of the potato slices. The temperature at which the crisping and browning occurs is defined as the *"frying temperature"*.

Summary

1. Minnesota-grown Chippewa, Russet Burbank, and Warba potatoes were used in this study.

2. The quality of the chips, expressed in terms of color, texture,

and flavor seemed to have no relation to the ash and nitrogen in the potato.

3. The frying temperature is the most important external factor in making good chips, and is conditioned upon the quantity of reducing sugar in the soaked slices.

4. The best frying temperature varied with the variety and the condition of the potato.

5. As the sugar content indicated by the picric acid-sodium carbonate test increased, the range of frying temperature for each variety became narrower, and both the immersion and frying temperatures had to be decreased.

6. The "fat/slice ratio" is defined as the ratio of mass of fat to mass of slices and is shown to be a significant factor in the initial temperature of the frying fat.

7. In all varieties the weight of chips increased with the percentage increase in dry matter of the slices.

8. The most obvious effect of storage was the increase in sugar in all varieties with the concomitant need for a lowered frying temperature to produce good chips.

9. As the storage period progressed, soaking potato slices tended to cause less loss of dry matter and nitrogen and to increase the fat requirement, with a resultant tendency toward increase in chip weight.

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PRELIMINARY REPORT ON THE USE OF SPRING GROWN SEED FOR PLANTING THE LATE POTATO CROP ON THE EASTERN SHORE OF MARYLAND

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The growing season is long enough for the production of two crops of potatoes in all portions of Maryland where the elevation is less than 1,000 feet above sea level. Most of the Maryland potato growers take advantage of this long season and grow two crops of potatoes every year. This practice is more extensive in the two southern-most Eastern Shore counties, namely, Worcester and Somerset. Northern or home-grown certified seed is usually planted for both crops. For the early crop, seed which has been stored in unheated basements or in pits, is planted. For the late crop, seed is used which has been kept in pits or in unheated basements from the time it was dug until about the first of April and then placed in cold storage until one to two weeks before it is planted. The time for planting the late potato crop extends from the middle of June to the early part of August, depending upon the variety and locality in which the crop is grown.

The spring potato crop can usually be harvested early enough

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The writers wish to acknowledge their indebtedness to R. T. Grant, County Agent of Worcester County, Md., and to Willard T. Pilchard for assistance in conducting experiments reported in this paper.

for planting the late crop. It is not being used for this purpose, however, because of the normal rest period through which the potato tubers pass before they will germinate. If a practical method can be found to make this spring-grown seed come up as soon and give as good a stand as stored seed, late potato growers will use it to plant their late crop. If this can be done they will be saved the expense of storing their seed, in addition to what they can also save by planting a portion of their spring crop instead of purchasing seed for their late crop or keeping it over from the previous year. It was with this object in view that the work reported in this paper was undertaken.

The first successful methods for shortening the rest period of potatoes were reported by McCallum (4) in 1909. Other investigators who reported successful methods were Appleman (1), Rosa (6,7,8), Muller-Thurgau (5), Loomis (3) and Denny (2). Methods employed by these investigators were the use of chemicals, heat, cold, and the removal of the skin around the eyes.

Only one of these methods, the sodium thiocyanate treatment reported by Denny (3) and studied further by Stuart and Milstead (9), appeared by the writers to be a practical possibility for the commercial potato growers in Maryland.

In 1932 studies with the use of spring-grown seed treated with sodium thiocyanate for planting the late crop were begun on the Eastern Shore of Maryland.

These studies have been conducted to the present time and are being continued in 1937. Prior to and including 1936 the Irish Cobbler, Katahdin and Chippewa varieties were used, and in 1936 the Warba variety was included. The methods recommended by Denny (2) were used in all of the tests with the exception of one in which the cut tubers were soaked in the sodium thiocyanate solution for one and one-half hours instead of one hour.

Samples of treated, stored and untreated seed were planted in these tests. The untreated seed germinated so late that no marketable tubers were formed before the vines were killed by frost. The treated Cobblers started to emerge about two weeks later than the stored Cobblers. All the stored Cobblers came up at about the same time, whereas the treated Cobblers came up at different times for an interval of about a week. When the treated Cobblers had emerged, there was only about three-fourths of a stand. After 1932 the treated Cobblers were planted two weeks before the untreated Cobblers and then they germinated about the same time as the stored seed. Similar results were obtained with the Chippewa and Katahdin varieties with

the exception that the treated tubers of these varieties emerged a little earlier than the treated Cobblers. Owing to the delayed germination resulting from the sodium thiocyanate treatment on the Cobbler, Chippewa and Katahdin potatoes, the spring-grown treated Warba potatoes were planted two weeks prior to the stored Warba tubers in 1936. To our great surprise they came up immediately with a 91.3 per cent stand and the plants were four inches high, when the treated Cobblers were just emerging.

Yield records were obtained in all of the fall test plots, as well as from seed planted the following spring from the treated and untreated plots. The yields from the treated spring-grown Irish Cobbler, Katahdin and Chippewa potatoes were always less than the yields from stored Irish Cobbler, Katahdin and Chippewa seed. With the Katahdin, where an extensive comparison was made between seed from treated spring-grown seed and seed from storage seed, there was no significant difference in yield. Furthermore, a very good yield (249 bushels to the acre of prime potatoes) was obtained from Katahdin seed potatoes treated each year for five years making ten consecutive crops in five years.

The yield from the treated Warba potatoes was very encouraging (79 bushels to the acre, primes) despite the fact that the vines were killed by a hurricane when they were not much more than half grown. Treated Irish Cobblers planted at the same time yielded only 28 bushels to the acre; treated Katahdins 16 bushels, and treated Chippewas, 19 bushels to the acre. Stored Katahdins planted at the same time as the treated seed, yielded 70 bushels to each acre.

Summary

1. The treatment of spring-grown Irish Cobbler, Katahdin, Chippewa and Warba potato tubers with sodium thiocyanate solution will shorten the rest period sufficiently so that a marketable crop of potatoes may be obtained on the Eastern Shore of Maryland.

2. The treated spring-grown seed of the Irish Cobbler will come up approximately two weeks later than seed from the previous year kept in cold storage; whereas the treated seed of the Katahdin and Chippewa varieties will come up approximately one week later. With the Warba variety in a one-year test, results seem to indicate that treated seed and stored seed will emerge at approximately the same time.

3. The plants from the treated seed of the Irish Cobbler, Katahdin and Chippewa varieties will come up over a period of one or two weeks and a reduction in stand may be expected. In a one year test

with the Warba variety all the plants germinated at the same time and the stand from treated and stored seed was almost the same.

4. There seem to be good commercial possibilities with the Warba variety in the production of a late potato crop in Maryland from spring-grown seed by soaking the cut tubers for one hour in a solution of sodium thiocyanate (one pound to twelve gallons of water) immediately before planting.

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POTATO YELLOW DWARF AND MEDIUM RED CLOVER

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Since 1917 when it was initially observed[1] a disease known as "yellow dwarf" has caused annual losses to the potato crop in New York and several other states and by its positive although sporadic increase in prevalence has given growers, especially the seed producers, considerable concern. The investigations of Black[2] showed that the clover leafhopper (*Accratagallia sanguinolenta*) is the principal, if not the only vector, of the virus responsible for the disease, and that medium red clover (*Trifolium pratense*) the chief host plant of the hopper, is a suscept. More recent observations and investigations by the writer in seeking a practical control of the dis-

ease would indicate that diseased medium red clover growing in fields in the vicinity of the potatoes may be the key to the problem.

The irregular distribution of the disease over the entire state of New York led to an investigation of the conditions favoring infection and spread. These investigations were stimulated especially by failure in earlier work to establish yellow dwarf experimentally in certain sections. A general survey begun in 1936, and still incomplete, indicates that the clover leafhopper is state-wide in occurrence but that only those individuals from certain sections are viruliferous. Further, a finding that may prove to be important is that the disease is restricted mostly to regions where medium red clover is grown. This seems to be true of the entire state and especially of those regions where yellow dwarf is reported as occurring annually for the past twenty years. Also, some indirect correlations are apparent between the introduction of medium red clover as a commercial crop and the subsequent spread of yellow dwarf in plantings of certain growers of seed potatoes. However, this does not explain the fact that no spread has taken place in certain regions where medium red clover is grown.

In these latter cases, however, it was found that the medium red clover was grown for one year only, in some cases dying out naturally, and in this way eliminating the possibility of this suscept serving as a source of inoculum. Another explanation may be advanced to account for the uneven spread of the disease. Should it be found, as suggested by the spread of the disease to potatoes from adjacent newly seeded clover (in oats) that the virus is carried in the clover seed, the chance distribution of diseased clover seed over the state might account for the irregular spread and occurrence of the disease of potatoes.

With the evidence to date supporting the restriction of the disease on potatoes to areas where medium red clover is grown, control of the disease through the elimination of this particular clover is indicated, rather than the elimination of the leafhopper which seems more difficult to accomplish. Should suscepts of the virus other than the potato and medium red clover be found, and especially should these be of general occurrence, the problem will, of course, be further complicated. Alfalfa, mammoth red clover and perhaps other clovers, unless subsequently found to be suscepts, may be substituted for medium red clover in locations where yellow dwarf is prevalent, with attention being given to the possibility of medium red clover occurring as an undesirable impurity in the other clovers. If the yellow dwarf virus is carried in the clover seed it may be possible through inspection and selection to produce seed free from the disease.

Experiments that are now being conducted should supply the answers to questions raised in this discussion of the potato yellow-dwarf problem.

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SOME NEW ACHIEVEMENTS IN BREEDING POTATOES FOR EARLINESS

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The creation of new early varieties of potatoes is a most difficult task. This was especially true in the case of the old breeding methods, the material used being limited almost entirely to the few varieties of *S. tuberosum* L. then available. As an indication of the difficulties entailed in this work we may take, for example, the fact that in Germany, where it is forbidden to grow wart-susceptible varieties, an exception has been made in the case of early varieties of potatoes.

The early varieties of potatoes are of great economic significance for the Far North and for supplying the industrial centers with potatoes during the summer months. Early varieties of potatoes are also of great importance to certain industries, e. g., for the early fall period of wine distilling, a period in which ordinarily lack of raw material is particularly acute. Consequently, much attention has been given to the creation of early, and medium early wart-resistant varieties of potatoes.

The cross Cobbler x Jubel, for example, gives progeny entirely immune from wart. According to our investigations in the Far North, in Khibini district (67° 44′ N.), this cross also gives progeny with a very short vegetative period, with very uniform, oval tubers, characterized by their excellent flavor, high cooking qualities and the large size of their starch grains. Intervarietal hybridization within the limits of *S. tuberosum* has shown that by crossing certain very early varieties with each other it is possible to obtain exceptionally early hybrids but most of

them give low yields. Such for instance are the hybrids Di-Vernon x Cobbler Epicure x Cobbler, etc. Hybrids obtained by backcrosses, using the same combinations, are more productive.

The combinations between very early and medium early varieties are of practical interest. From the combinations Cobbler x Fürstenkrone and Epicure x Alma I. A. and M. N. Veselovsky have produced hybrids, which have already shown, under field conditions, high indices with respect to earliness and yield (Veselovsky's selections Nos. 414, 423, 123). The world genofund of *S. tuberosum* L., as regards the creation of early and productive varieties of potatoes, may be considered to have been utilized to a quite exhaustive extent by the combined efforts of potato breeders of all countries.

The discovery of new species of potatoes, specimens of which were collected by expeditions of the Institute of Plant Industry (S. M. Bukasov, S. V. Juzepchuk, N. I. Vavilov, and Kesselbrenner), opened up new possibilities for breeding potatoes for earliness.

The new 48-chromosome species, *Solanum andigenum* Juz. & Buk., which we have taken for hybridization with commercial varieties, is characterized—when grown in the Leningrad Region or the Khibini district—by late and slow formation of tubers. Several forms of *S. andigenum* under field conditions in the Leningrad Region do not form tubers at all. It would be a great error, however, to judge as to the productivity of forms of this species by the yields obtained under conditions in the Leningrad Region or other similar localities. Many forms of *S. andigenum,* when grown under suitable ecological conditions —at Maikop (North Caucasus) and in the Pamirs—have proved to be very highly productive. To realize all the potentialities of *S. andigenum* forms as regards economically valuable characters and to reveal their significance is only possible by an all-sided study of these forms.

On the basis of a study of hybrid material, obtained as a result of numerous cyclic crosses, it has been found that in the F_1 from the combination *S. andigenum* x *S. tuberosum* the following characters are dominant: late maturity, fertility, ability to form tubers, and a large number of tubers to the cluster, the last-mentioned being a character of *S. andigenum.* Of the interspecific crosses those between *S. andigenum* and *S. tuberosum* give greatest promise of producing high-yielding hybrids with clusters containing many tubers. As regards size of tubers, these interspecific hybrids are not inferior, and in some cases are superior, to commercial varieties of *S. tuberosum.*

Hybridization work with *S. andigenum* in combination with *S. tuberosum,* aiming to obtain early and productive varieties of potatoes,

did not give the desired results in F_1, since only the second part of the task set—high productivity—was realized.

By crossing the interspecific hybrids obtained in this manner with early commercial varieties, e. g., Early Rose, Epicure, there has been obtained a combination of the following characters: early formation of tubers, short period of tuber formation, early normal completion of the vegetative period, and high productivity. Of such combinations the following merit particular attention: (1) Early Rose x F_1 (*S. andigenum* var. *taccla* x Fürstenkrone); (2) Epicure x F_1 (*S. andigenum* var. *tocanum* x Centifolia); and (3) Early Rose x F. (*S. andigenum* var. *tocanum* x Centifolia).

NOTES AND BRIEF ARTICLES

Report of the New York Conference of Potato Breeders, Potato Pathologists, and Horticulturists

The second summer meeting of the National Potato Conference was held in New York, from the 23d to the 27th of August, inclusive. The tour started in Western New York near Batavia, proceeded into Steuben County then through Central New York and terminated in Northern New York. Stops were made at typical experimental plots of practically every phase of the potato improvement project. The local committee headed by Dr. Donald Reddick planned an interesting and very much worthwhile trip and Dr. Reddick saw that the plan was carried out on time. No untoward incident marred the trip and everyone seemed to be enjoying himself while, at the same time, he was becoming familiar with the New York potato situation.

Drawing from a wide area the group numbered 34 at one time. Representatives were present from Washington, D. C., Canada, Nebraska, Iowa, Michigan, Ohio, Pennsylvania, New York, Virginia, Maryland, New Jersey, Rhode Island, and West Virginia. There were 15 pathologists, 9 horticulturists, 3 potato breeders, 2 botanists, and 3 administrative officers. At every stop a few farmers joined the group and in some instances took an active part in the discussion.

There are five potato-rotation experiments in New York of a common design with some modification to meet the different local conditions of the major potato areas in which they are placed. These experiments under the direct charge of Dr. Ora Smith are designed to determine the effect of the cropping system on (1) yield and quality of potatoes; (2) yield of other crops in the rotation; (3)

prevalence and extent of damage by insects and diseases; and (4) changes in the soil. There are nine rotations in each experiment and all crops in each rotation are grown every year. Each treatment is replicated five times. These experiments have been conducted for two years and of course are to be continued for several more years. The tour stopped at the Genesee County and Steuben County rotation experiments.

The soil reaction experiment in charge of Dr. Smith was observed at Ithaca. This experiment was designed to study the relation of soil reaction to growth emergence stand, tuber set, scab, yield, composition, and culinary quality of potatoes. Started in 1932 with the soil pH 5.4 to 5.7; using sulfuric acid to increase acidity and hydrated lime to decrease acidity, the pH range of the several plots has varied from a low of 4.68 to a high of 8.1. Important differences have been found in several categories of information as listed in the purpose of the experiment.

An experiment designed to determine the effect of several seed treatments on the incidence of wilt, 'Z' disease, and other potato diseases was observed near Batavia. This experiment and the spraying experiments are in direct charge of Dr. F. M. Blodgett. In the spraying experiments the usual formula for bordeaux has been varied by applying heavier amounts of copper early in the season and tapering off to lighter proportions late in the season. Certain forms of copper and sulfur dusts are being used in these experiments.

The tour made one stop at an extensive layout of small potato plots each surrounded by different crops. This experiment was designed to measure the effect of crops, other than potatoes, on the spread of yellow dwarf. It is a pleasure to report that yellow dwarf apparently is gradually disappearing as a serious potato trouble. Another experiment was visited, which was under the direction of Dr. G. F. McLeod. This test was planned to observe the behavior of clover leafhoppers relative to their ability to transmit the yellow dwarf virus to many different plants, other than clover.

The variety trials under the direction of Dr. E. V. Hardenburg were extremely interesting and provoked considerable discussion as to the merits and demerits of the several new varieties. Apparently there is not too great unanimity of opinion as to the relative worth of some of the varieties. That is to be expected because the potato is particularly sensitive to its environment insofar as that response is registered in appearance and quality.

The breeding of potatoes for resistance to disease, which Dr.

D. Reddick has so capably handled, was illustrated in the trials at Ithaca and Sterling. Dr. Reddick's first concern was resistance to late blight and now it is an accomplished fact. The visitors saw innumerable seedlings that were entirely immune to late blight and many of these seedlings produce commercially acceptable tubers. Dr. Reddick's potato patch contained a great deal that was not only of especial interest to the breeder, but to the group as a whole. The scab resistance trial plot at Sterling was located on a piece of muckland that was as nearly one hundred per cent infested with the potato-scab organism as any soil could be. The check rows of Russet Burbank were practically clean and every tuber in the check rows of Irish Cobblers had some scab lesions, many of them completely covered. A row of seedlings was planted between the Russet Burbank and the Irish Cobbler. At this time it was too early to make observations regarding scab resistance, nevertheless, there were differences apparent among the seedlings.

Another phase of potato breeding, namely, that of yield and quality, is in charge of Dr. J. R. Livermore. The two methods of attack are clonal selection and hybridization. The tour stopped at one of the clonal selection plots where Smooth Rural and Russet Rurals were being grown. Differences of 15 to 20 per cent in yield can be uncovered by the process of clonal selection within a variety and these differences persist. An extensive seedling trial at Perry for the purpose of discovering heat and drought-tolerant strains that produce quality tubers under Western New York conditions illustrated the method of developing such types, and the field plot technique used in the testing of seedlings or strains.

At Gabriels in the Adirondacks another test plot was visited. At this place, under almost ideal conditions for the normal development of potato tubers, another complete trial of unnamed U. S. D. A. seedlings and the first-year planting of hundreds of Livermore's seedlings was observed. The hybridization in this breeding project is done at Gabriels. Many varieties, foreign and domestic, and also new seedlings were in the breeding plot.

Both on the muck near Elba in Genesee County and on the upland soils of Central New York near Homer the tour stopped at several fields of the new varieties. On the muck the Warba, Chippewa, and Katahdin were doing well. The Chippewa in the upland field was producing exceptionally smooth white tubers. The Katahdin, as always, produced a crop of uniformly beautiful tubers,

usually a very high percentage of U. S. No. 1 stock on both muck and upland.

The consensus of opinion of the visitors was that the trip had been a pleasant and profitable one. The group voted to meet next summer at Presque Isle and Fredericton, N. B.—during the month of August.—J. R. Livermore.

SECTIONAL NOTES

Colorado

Crop prospects declined considerably during August because of the extremely hot weather and lack of sufficient moisture. Psyllids have also caused considerable damage, especially in the San Luis Valley. It is estimated that the crop in that section will not be more than 65 per cent of last year's large crop. If cooler weather and showers prevail during the latter part of September, however, there may be some improvement in the crop, providing we have a late frost.

The Greeley crop is late and the damage from flea beetles has been more severe than usual.

Meetings have been held on crop control and marketing agreements, and growers seem to be in favor of the plan, provided other large producing states will also sign the agreement. (Sept. 9).—C. H. Metzger.

Connecticut

The extremely hot and dry weather during the first three weeks of August has reduced the prospects of potato yields markedly, particularly on the early-planted fields on which the majority of the vines were dead before the heavy rains fell during the latter part of the month. (Sept. 10).—B. A. Brown.

Indiana

There is not much change in the potato situation. An estimated yield of five and a half million bushels is forecast which is less than one-half our consumption. Prices are about steady now on Cobblers at $1.15 to $1.30 per cwt. Some localities need rain although the plants are not suffering a great deal at present. (Sept. 7).—W. B. Ward.

Kentucky

The "second crop" Cobblers are growing nicely. They have grown well from the beginning because of plentiful moisture during seed preparation season. Stands are well over 80 per cent, which is highly satisfactory for second crop. The disturbing feature is that blooming, "as of September 1", has begun. The high temperatures and hot winds of the first two weeks of September sometimes play havoc with Cobblers that are just beginning to form tubers. Nevertheless, the prospect at present is a good one. (Sept. 6).—John S. Gardner.

Maine

Twenty-seven meetings are being held this week, throughout Aroostook County (from the 13th to the 18th of September, inclusive), by the Extension Service for balloting connected with the Marketing Agreement and Agricultural Conservation Potato Goal. An opportunity will be given for frank discussion of all phases of the respective programs. Much interest is being manifested as is evidenced by voluntary discussion groups which are being held at scattered points. This is indicative of the increased importance attached to marketing by growers every where.

As yet, figures of the total acreage of seed certified by the state this season are not available. Certified seed that has already been dug is being harvested in splendid condition. Probably never in history has the crop in Maine had so much style and quality.

Complaints are being received from all sections regarding the small "set" and ill-shaped tubers in the later varieties of which the Green Mountain is the principal one, of course. The rainy period experienced during the last forty-eight hours will probably change the situation considerably. Nearly all fields of late varieties still show green tops. This probably indicates that the tubers will grow markedly under the influence of these rains. At the same time there is no question that the number of potatoes to the hill is smaller than usual which will, of course, be a factor in offsetting the 12 per cent increase in total acreage.

Harvesting is getting well under way this week although Green Mountains are still too green to harvest extensively.

Prices are being maintained at approximately 50 cents per cwt. F. O. B. with demand for more potatoes than are available at this figure. Reports to date on the quality of potatoes shipped have

been highly favorable. There has been a wide distribution of shipments to date, which is an important fact to consider in the year's operation. (Sept. 14).—Frank W. Hussey.

Field inspection has been completed by the State Certification Service, and a total of 25,767 acres of potatoes, by varieties, has been certified:

Green Mountains	11,117
Irish Cobblers	10,503
Spaulding Rose	845
Chippewa	1,399
Katahdins	1,099
Bliss	475
Russets	278
Warba	43
Early Rose	4
Early Ohio	2
Blue Victor	1

This is somewhat higher than last year. The Green Mountain variety shows the largest increase. There is not an excessive increase in Cobblers, and there is a large reduction in Spaulding Rose. Chippewa, Katahdins, and Bliss will probably be sold readily and the only salesmanship that will be required will be in connection with the Green Mountain variety. The 1936 figures are as follows:

Green Mountans	6,517
Irish Cobblers	9,255
Spaulding Rose	913
Katahdins	587
Chippewa	302
Russets	252
Bliss	221
Golden	18
All Others	16

Cobblers are being harvested and are very bright. This variety will be the outstanding one of the season as far as general appearance and type are concerned. The later varieties have passed through a spell of hot dry weather and will not yield so high as in an average season.

The first car of Certified Bliss has already been packed for Southern Florida, directly from the field. (Sept. 15).—E. L. Newdick.

Massachusetts

The Irish Cobbler crop has been harvested. The harvesting operations were delayed as a result of low prices. The Mountain crop, which is somewhat spotty, is now being dug. Wet weather continuing throughout most of the season in the western part of the state has caused considerable rot and poor yields where the plants were not well sprayed.

More favorable conditions existed for most of the commercial crop which shows fair yields with only occasional rot on the poorer sprayed fields, and average to good yields on well-sprayed Mountains. Prices continue low.

Although farmers have not yet been advised regarding any proposed control measures, little comment has been received in demand for such measures. (Sept. 14).—Ralph W. Donaldson.

Montana

Indications at present point towards a rather light yield to the acre in Montana. This is possibly because of the few hot days at a critical stage in the growth of the plants which seem to have destroyed portions of the root systems.

In many of the fields, the set is not only light but the tubers are smaller than they were a year ago at this time. This, together with poorer stands than we experienced a year ago, will probably tend to offset the increase in acreage. Frosts visited a few sections of the state during the latter part of August. In most cases the damage was slight but in one valley the frosts were heavy enough to practically stop further growth. Our acreage for certification this spring was larger in the beginning but the rejections have been slightly heavier than a year ago so that the acreage that passed final field inspection will be the same as last year. (Sept. 4).—E. E. Isaac.

Nebraska

During the past two weeks, Western Nebraska has had rainfall in varying amounts from light showers to floods, ranging from six to

eight inches. The flood conditions have occurred in small areas but little damage has resulted. Together with the extreme heavy rainfall, there were a few hail storms which also complicated the situation.

As a result of the hot weather and high humidity, conditions have been ideal for Early Blight infection, which now threatens to reduce the Nebraska crop materially. Prospects at this time indicate half a crop in the dry land area, and somewhat of a reduction in the irrigated section, as yet undetermined. Although it may be possible for conditions to change which might check the infection, this is rather improbable.

The average for frost date in this section is about the 25th of September. Until the rainy period occurred there were practically no tubers set, and at best not more than ten to twenty bushels to the acre in the ground, but with good growing conditions until frost occurs the prospects were that we should have a fairly good crop. With the event of Early Blight this picture is being changed materially from day to day.

Meetings are being held throughout the territory to determine the growers' reactions to the proposition of the marketing agreement and crop control. Generally speaking, the growers are apparently in favor of such control measures. However, growers feel that the committee in charge of such control should have authority not to apply control measures in the event of a short crop. At the time of this writing the outcome of the plan can not be given, but the writer's personal opinion is that it will be put into effect.

The acreage of certified seed has been reported. Little change in the acreage is taking place. There has been some reduction caused by losses from insects and drought in isolated areas. There are approximately 8500 acres of the Bliss Triumph variety entered for certification, and 300 acres of the Irish Cobbler variety.

Field inspection has practically been completed. Some rejections have been made because of Fusarium Wilt. Some sections seem to be getting considerable infection in the field, and a large percentage may be rejected in the bin. The quality of the potatoes in the ground at this time is not so good as usual because of the alternating extremely hot weather and the cold moist periods. Heavy losses are to be expected because of the off-type and scab.

Early digging in the irrigated sections has been in operation for two or three weeks. These potatoes are being sold at 60 cents and 65 cents to the grower, for potatoes grading 85 per cent U. S. No. 1 or better. The quality of the early harvested crop has been good ex-

cept for some trouble caused by sunscald. Since the Nebraska growers do not have this trouble, as a general rule, and owing to their inexperience, they have been digging on days that were extremely warm and trouble has resulted.

The late crop of potatoes will be dug between the first and tenth of October, throughout the irrigated and dry land sections. (Sept. 13).—Marx Koehnke.

Nebraska

Early blight is more prevalent than usual in the late potato crop in the North Platte Valley. As a result of the blight many fields are ripening and will soon be ready to harvest. Normally, digging of the late potato crop does not begin until after the first fall frost, or sometime during the latter part of September. The major portion of the crop, however, is making a healthy, vigorous growth at this time. During the past three weeks temperatures have been very favorable for tuber growth. Some concern is being expressed regarding the number of oversize tubers which will likely be produced in the absence of an early fall frost. In healthy fields tubers are very large at this time, and much further growth will make many of them oversized and consequently somewhat undesirable from the standpoint of the best market quality. Stem rot and virus diseases are about as common as usual. Some fields under irrigation have been rejected for certification because of the presence of these diseases. The late crop has not been damaged by the purple top disease. In general, it is expected that the second crop of potatoes will be of good quality, except for some possible oversize tubers.

In general, farmers have expressed approval of the proposed market control plan which would prevent the shipment of culls in interstate commerce. If this plan can be put into effect soon enough some improvement in the price of potatoes is expected to occur. As the situation exists at present, growers will probably receive from forty to fifty cents a hundred for their potatoes at digging time.

On the 17th of August a potato field day was held at the Scottsbluff Field Station. During the morning the visitors examined the various experimental projects with potatoes, including 26-year rotation experiments, irrigation tests, variety tests, spraying tests and a breeding project, which is being conducted by Dr. H. O. Werner

with the object of improving the quality and disease resistance of the Triumph potato. (Sept. 13).—Lionel Harris.

New York

All field inspections for certification are practically complete. The acreages which passed in 1936 and 1937 are as follows:

	1936	1937
Irish Cobbler	383	184
Green Mountain	381	404
Smooth Rural	477	438
Russet Rural	326	305
Katahdin	35	58
Chippewa	11	119
Warba	20	32
Bliss Triumph	68	99
Early Ohio	2	5
Early Rose	0	6
Spaulding Rose	0	4
	1703	1654

The most significant change is a 60 per cent reduction in the acreage of Irish Cobblers. This is apparently because of decreased interest in this variety since little stock was rejected. Rejections for all varieties amounted to 200 acres, or eleven per cent of the acreage submitted. In general the season has been favorable for a good crop, although in many places rainfall has been excessive to the extent of causing the complete loss of some fields by drowning. Late blight is present in all parts of the state but little damage has been reported as yet. Nearly all the seed growers have their fields well protected with spray materials. (Sept. 12).—K. H. Fernow.

Following generally favorable growing conditions during July, very high average temperatures prevailed over the entire state throughout most of the month of August. Infestation of both leafhoppers and flea beetles was heavy in many areas. Even though certain local areas of Western New York experienced some lack of rainfall during the month, in general, the rainfall was above normal. The result is that late blight is present in many fields and whether it will

develop in epidemic proportions depends on the weather from the present time.

Growers throughout Western and Central New York, who have examined their fields for yield, report a small crop in prospect, probably the result of the extreme heat. The crop on Long Island will be fairly large,—particularly the Cobbler variety. Growers on the Island have deferred digging on account of the slow market. The crop in Northern New York is in excellent condition regarding both the size and quality, although blight has appeared in many fields. From present indications, the August estimate of 28,000,000 bushels for New York will probably be considerably reduced in the September report.

Fewer potatoes than usual were exhibited at the State Fair this week. This is partly because of the fact that the planting date was later than normal and very few growers have tubers large enough to dig. The quality of the potatoes shown was excellent.

On the 19th of August, the attendance at the annual field day of the Empire State Potato Club at Homer, New York, was estimated at 6,000. The affair was decidedly successful. (Sept. 9).—E. V. Hardenburg.

Ohio

The early crop of potatoes is practically all harvested. The digging of the late crop is starting in early planted fields.

Our late crop will be much below last year's production. Because of the extremely wet weather the stands are generally poor. Many growers have neglected their crops probably because their stands and prices seemed discouraging. Owing to this neglect, there is much late blight in northeastern Ohio and the vines in several fields are completely down. During the last week of August and the first part of September the hot weather we experienced checked the blight but damaged the crop. Should we have favorable late blight weather the crop will be further reduced, as many fields were planted late and need several week's growth.

The cooperative grading and marketing of potatoes will continue but the volume will probably be below last year on account of small crop.

A storage and packing plant is being built in Columbiana County. (Sept. 14).—E. B. Tussing.

Oregon

Growers in this state are interested in the proposed plans for a potato marketing agreement. The attitude to date, however, is that a marketing agreement which would prohibit the shipment of grades lower than U. S. No. 2's could only be enforced if it were accompanied by the adoption of compulsory grading. This state has had compulsory grading for nine years, and it has worked out very well. Practically speaking, there are no culls shipped here, except in years when prices are extremely high. Each lot of potatoes sold in the state must be graded and must carry a brand plainly showing the grade. This also applied to retail sales in stores and even applies to advertising. Under ordinary circumstances people will not buy potatoes labelled "culls," and so the law has had the practical effect of prohibiting their shipment except in years when the price of No. 1's at primary points has gone higher than two dollars per hundred.

We have had a cool summer in this state, and in our high elevation areas there have been light frosts every few nights during the latter part of August and so far in September. A great many potatoes in these areas are frozen, the frost injury running from complete kill to only 10 or 15 per cent. It is likely that our Klamath and Central Oregon shipping areas will have their shipments reduced at least 25 per cent. (Sept. 7).—E. R. Jackman.

Pennsylvania

At the present time the final field inspections are being completed throughout the state. It is indeed encouraging to see how well most of the certified fields are standing up under the heavy attack of late blight. It has been many years since Pennsylvania potato growers have experienced late blight in the proportions to which it is encountered this year.

These severe conditions are the result of the excessively wet weather which prevailed in most of the potato-growing regions throughout the greater part of July. This wet weather not only stimulated the development of the blight organism but completely stopped spraying and dusting operations for approximately two weeks. For the last ten days, however the weather has been generally dry and late blight is again under control. In many places the relief came too late and now the only fields that remain green are those that were thoroughly sprayed early in the season.

At this time no definite estimate can be made with regard to the number of bushels of certified seed that Pennsylvania will produce. We do know, however, that at the present time there are 845 acres of certified seed this year as compared with the 740 acres of seed certified in 1936. (Sept. 13).—T. C. Johnson.

Our late potato crop seems to be of good size and quality where good cultural conditions prevailed. There are some exceptions, particularly in Somerset County, and some northwestern counties where blight struck early and severely. Here the crop will be very light and the tubers small. Extremely hot weather damaged the crop severely where the crop was not thoroughly sprayed, and also killed the late potato vines on most farm patches during the early part of the season.

The Katahdin seems to be increasing both in popularity and acreage. The appearance of the crop in Lehigh and other eastern counties is generally better than usual with little or no second growth. The moist weather conditions during recent weeks has interfered with digging to a certain extent.

The Potato Growers' Association is conducting an active marketing campaign planning to use U. S. Standard grades. Our new potato marking law requires that all potatoes sold in the state in closed containers must be marked unclassified, or with the grade, the packer's name, and address. This makes it necessary to hold several meetings in order to explain and demonstrate grading, and will probably mean a tightening up and better grading on the part of the commercial growers. (Sept. 15).—J. B. R. Dickey.

Rhode Island

The Cobblers have been harvested. On the average, the yields were very good. The earlier planted fields produced best results because the crop was largely "made" before the dry spell arrived. Green Mountains are being dug. A great reduction in yield resulted because of the dry weather during July and August. Several growers have grown Chippewas with satisfactory results so far. This new variety looks very promising for our conditions. (Sept. 11).—T. E. Odland.

Virginia

The poor results of the past year have led most of our farmers to believe that the lack of a program on the part of the vegetable and potato growers, has been one of the reasons they have not prospered to the same extent as other agricultural lines. Therefore, they now believe they should work together and form an organization which will allow them to adapt themselves to whatever developments take place, to the end that they can make the most of the opportunities which become available to them.

In addition to results obtained on a national scale through legislation or bargaining power with the big markets, they also bear in mind the several local problems which are rather acute. One may be a credit problem, with the theory growing that the farmers should develop and handle their own credit, and quite possibly extend that into cooperative supplies. In addition, the problem created by the invasion of the Japanese Beetle, which, under established precedent will become more acute, has to be solved. This problem may compel the use of properly equipped centralized packing houses. If this is the case, it will need organized grower effort. The matter of crop reporting, although of no great local interest, is of some concern, and could be properly handled through a local organization with perhaps more accuracy and with less expense than if it were handled almost exclusively from the Washington office. Perhaps the matter of primary importance is proper recognition in the 1938 Conservation Program, with two main objectives. First, to obtain benefits commensurate with those received by farmers who grow cotton, tobacco and peanuts, taking into account the production cost involved and the value of the crop; and, secondly, the establishment of a procedure that will prevent the diversion of acreage from other basic crops into vegetable or potato production through the reduction of benefit payments imposed on account of growing these crops in excess of the depletion acreage set up for these crops.

There is another consideration to be taken into account by our growers, that is, signs seem to point toward production control measures at the next Congress. Although many growers are opposed to control measures and others favor it, still the majority feel that if production control measures are put into effect, that the potato and vegetable interests should have similar consideration in order that they may not suffer at the expense of other production lines. (Sept. 14).—G. S. Ralston.

WANTED

Back numbers of the Potato News Bulletin and the American Potato Journal.
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American Potato Journal Vol. 3; Vol. 4; Vol. 5, Nos. 3, 5, 6 and 7; Vol. 6, Nos. 4 and 6; Vol. 7, Nos. 4 and 6; Vol. 8, Nos. 5, 6 and 7; Vol. 9, Nos. 4 and 6; Vol. 10, Nos. 4 and 8; Vol. 12, No. 2.

Communicate with William H. Martin, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

American Potato Journal

PUBLISHED BY

THE POTATO ASSOCIATION OF AMERICA

SOMERVILLE, N. J. NEW BRUNSWICK, N. J.

GRADES MUST BE PROTECTED

In New Jersey a large part of the potato crop was inspected at the shipping point this year. Those shipments which failed to meet the requirements of the U. S. No. 1 grade were sold by the producer as a commercial grade. He received 10 cents a sack less for these potatoes, despite the fact that the shipment often failed to meet the requirements of the better grade by only a small margin. This same situation no doubt exists in other states.

We all appreciate the need of marketing a uniform product. Shipping point inspection has contributed much in this direction. The men entrusted with this work have made an excellent record and their efforts are appreciated by all concerned with marketing the potato crop. The difficulty with the present situation lies in the fact that, although the grower receives a reduced price for his crop a considerable number of these potatoes are later sold to the consumer as U. S. No. 1's. As usual the producer takes the loss. This situation must be avoided next season.

At the Washington meeting of vegetable and potato growers it was recommended that all potatoes for consumption, moving in interstate commerce be branded, tagged or described in terms of U. S. grade or as unclassified. It was also advocated that the States enact legislation which would provide that each package of potatoes sold or delivered to the consumer be marked with the appropriate U. S. grade or as unclassified.

Action of this kind appears to be necessary if the tendency to pay commercial grade prices to the producer and sell at U. S. No. 1 prices to the consumer, is to be curbed. Until this is done the producer is certain to regard shipping point inspection with suspicion since he realizes that for years he received U. S. No. 1 prices for potatoes, little or no better than those he is now selling as a commercial grade.